	• Any cameras may be either fixed or movable; (Col 3: 8-11), (Col 4: 55-59)	**10: 42-47)**, (** pg. 46, paragraph 3) • 2nd Set is all movable cameras for game videoing (/filming); (* **Col 10: 66 – Col 11: 4)**, (** pg. 46, paragraph 4 – pg. 47, paragraph 1)
	• No requirement that camera views overlap to completely cover predefined area; (Col 2: 27-35), (Col 7: 53-56), (Col 8: 36-40), (Col 10: 3-7)	• 1st Set of Cameras must have overlapping views that completely cover predefined area; (* **Col 13: 63 – Col 14: 10)**, (pg. 46, paragraphs 2-3)
	• All cameras perform the same basic figure X, Y ***centroid*** tracking; (Col 4: 35-45); (Col 5: 58-62)	• 1st Set of Cameras exclusively for figure X, Y ***centroid*** tracking; **(* Col 15: 36-40)**, **(* Col 15: 47-51)**, **(* Col 18: 13-18)**, (pg. 46, paragraphs 2-3) • 2nd Set of Cameras is for Videoing and is not required for figure X, Y centroid tracking; (* **Col 13: 41-44)**, (pg. 46, paragraph 4)
	• There is an implication that the multiple videoing / tracking cameras are at a perspective view, thus tracking the figures centroid is made more difficult and requires either triangulation, based upon two overlapping camera views or ranging, based upon dynamically adjusting the camera's focus to estimate the distance from the camera to the figure; (Col 6: 15-25)	• The 1st Set of Cameras is able to determine X, Y Centroid with sufficient accuracy since the set maintains a view the is substantially parallel with the tracking surface on which the figures are moving about, therefore triangulation is not necessary for two dimensional calculations; (* **Col 13: 63 – Col 14: 4)**, (** pg. 46, paragraphs 2-3) • Ranging via dynamic focus adjustments is time consuming and too slow for real-time sports tracking, especially in light of some sports objects traveling at speeds in excess of 100 miles per hour; (* **Col 15: 61 – Col 16:8)**
	• Alternatively to triangulation and ranging, figure centroids can be calculated if assumptions are made about physical size, again this is because the cameras are placed at a perspective to the figure; (Col 6: 65- Col 7:4) • Still further, by intentionally placing the camera at a perspective and known angle to the tracking surface, this angle along with the detected vertical position of the figure in the image can be used to estimate the figures X, Y centroid; (Col 7: 4-8)	• Very often players in a sporting contest will fall down or at least bend over, thus significantly altering the apparent size from a perspective view, by switching to a primarily overhead view, these changes in player posture become less important and tend to dominate the Z (height) dimensions rather than the X, Y centroid; • Placing the tracking cameras at a perspective angle with the tracking area makes them highly susceptible to figure / player occlusions where one player is blocking the view of another, thus defeating a perspective based tracking technique;
	• All cameras function independently and discontinuously depending upon the current X, Y centroid location of the figure being tracked – i.e. each camera only functions when the system determines that the figure being tracking is within its potential view; (Col 9: 14-16), (Col 9: 53-Col 10: 3); (Col 10: 7-11)	• Each and every camera in the 1st Set of Cameras continuously look for figures throughout the entire predefined time, regardless of the current X, Y centroid location – i.e. regardless of whether or not the figure is in that cameras current view; **(* Col 15: 47-59)**, **(* Col 16: 12-23)**, (** pg. 16, paragraph 2)
B. Figure Tracking Algorithm	• Multiple figures may be moving throughout the entire predefined area, throughout the entire predefined time; (Col 4: 22-23)	• (same); **(* Col 15: 36-42)**, (** pg. 16, paragraph 2)
	• Of all the multiple figures, only a selected figure of interest is tracked and videoed, all other non-	• All of the multiple figures moving within the predefined area are tracked; **(* Col 15: 36-42)**, (** pg.

	selected figures are intentionally ignored; (Col 4: 10-13); (Col 4: 16-19); (Col 4: 35-45)	18, paragraph 2), (** pg. 13, paragraph 2), (** pg. 16, paragraph 2)
	• Since there is no requirement that the entire predefined area be in view of at least one camera at all times, figure tracking can only be initiated when the desired figure appears in a first camera; (Col 4: 3-10)	• Figure tracking is automatically initiated for each figure as soon as it enters any portion of the predefined area (and is therefore now in view of at least one camera in the 1st Set of Cameras); **(* Col 15: 47-51)**, (** pg. 51, paragraph 3)
	• Since there is no requirement that the entire predefined area be in view of at least one camera at all times there may be some locations where figure movement must be estimated / predicted because the figure is not in view to be tracked; (Col 7: 57-60), (Col 8: 8-14), (Col 8: 36-40), (Col 10: 3-7)	• Since the 1st Set of Cameras is specifically limited to a contiguous formation completely covering the predefined area, all figures are within the view of at least one camera at all times; **(* Col 14: 3-10)**, (** pg. 46, paragraphs 2-3)
	• The figure of interest may be automatically detected and manually selected, for tracking, which is the preferred approach in a "busy scene" (such as a sporting event); (Col 4: 3-7), (Col 4: 20-25), (Col 7: 36-41)	• All figures are of interest and are all detected automatically and therefore also automatically selected for tracking, including within a busy scene; **(* Col 18: 55 – Col 19: 17), (* Col 20: 61-65)**, (** pg. 16, paragraph 2), (** pg. 47, paragraph 3)
	• The figure of interest may be automatically detected automatically selected, based upon "detectable differences in the particular target profile such as size, shape, speed, etc."; (Col 4: 8-10)	• At least with sports, there is often no realistic means for differentiating between targets (players) based upon size, shape, speed, etc. • All figures are always tracked and in a sporting event, they are differentiated by uniquely encoded markings; **(* Col 11: 15-25), (* Col 11: 58-61), (* Col 19: 14-16)**, (** Fig.s 1-12, elements 560, 574), (** pg. 7, paragraph 2), (** pg. 31, paragraph 2)), (** pg. 34, paragraph 3 – pg. 35, paragraph 1), (** pg. 49, paragraph 3), (** pg. 50, paragraph 4 – pg. 51, paragraph 1)
	• The figure tracking algorithm includes a "determinator" whose responsibility is to determine the location of the figure within the current camera's field of view and the camera's physical location within the predefined area; (Col 3: 54-60)	• There is no equivalent determinator required since all cameras in the entire 1st Set of Cameras are always searching their fields-of-view for any and all figures only with respect to their current view, where this information is then passed to the tracking algorithm that combines these detected centroids from all 1st cameras in order to determine every figure's current physical location within the predefined area; **(* Col 13: 21-25)**, (** pg. 16, paragraph 2), (** pg. 31, paragraph 2)
	• The figure tracking algorithm next uses a "controller" to determine which cameras' fields of view include the figure's physical location and then select the appropriate next camera to "handoff" videoing of the figuring to, and therefore also handing of the responsibility of figure tracking; (Col 3:60-65), (Col 4: 27-45), (Col 7: 42-52)	• There is no equivalent "controller" that is selecting between cameras in the 1st Set of Cameras to determine which camera's view currently includes a selected figure, so as to then "handoff" responsibility for videoing that figure to the selected 1st Set camera – again, this is because all 1st Set cameras are continuously tracking, regardless of whether they include a selected figure, let alone any figure; **(* Col 13: 21-25)**, (** pg. 16, paragraph 2), (** pg. 31, paragraph 2)

C. Multi-camera Videoing System	• There is no distinction between tracking cameras and videoing cameras, therefore any camera that is tracking figure centroids may also video and vice versa, in the end every camera may at some point be a part of the figure centroid tracking function; (Col 4: 10-13) • However, since only those cameras with a view of a selected figure are inputting data to the figure tracking system, then only those cameras are also creating video for the system;	• One or more moveable cameras form a 2^{nd} Set of Cameras, entirely distinct from the 1^{st} Set of Cameras that have no responsibility for figure centroid tracking (all of which is done with the 1^{st} Set of fixed Cameras); **(* Col 10: 66 – Col: 11: 4), (* Col 13: 41-44), (* Col 15: 19-30), (Fig. 8 – element 40 for videoing vs. element 20c for X, Y tracking), (* Col 21: 32-34), (* Col 22: 4-6)**, (** pg. 31, paragraph 2), (** pg. 34, paragraph 3 – pg. 35, paragraph 1) • Capturing video of the entire predefined area leads to the ability to combine all sources of video into a single composite view – therefore, video of an current "figure empty" portion of a sports playing field is also of value because is holds a place with respect to all other views;
	• Since only the centroid of the selected figure is being tracked, the system has insufficient information for alternating between possible movable cameras to direct "best-views" of a selected figure, consequently an operator is relied upon to pick from multiple possible views; (Col 7: 36-52)	• Since the centroids for all figures are always tracking, the system uses this information to dynamically adjust which 2^{nd} cameras are assigned to video which figures; **(* Col 13: 41-44), (* Col 15: 19-30)**, (** pg. 31, paragraph 2), (** pg. 34, paragraph 3 – pg. 35, paragraph 1)
D. "Figure feature / location point" Tracking System	• There is no teaching presented to allow for the determination of a three-dimensional body-point model of the selected figure, let alone all figures within the predefined area;	• Each of the multiple movable cameras in the 2^{nd} Set of Cameras may be used to gather additional video data that is searchable for specific locations on each tracked figure, where the locations may be tracked in three dimensions and provide a model of each figure; **(* Col 11: 15-28)**, (** pg. 31, paragraph 2)), (** pg. 34, paragraph 3 – pg. 35, paragraph 1), (** pg. 46, paragraph 4 – pg. 47, paragraph 1), (** pg. 50, paragraph 2)
	• There is no teaching presented for adhering markers to key body joints of the figures to be tracked in order to support the creation of the three dimensional body-point model;	• One or more location on each figure may be marked with reflective, retro-reflective or fluorescent markers that are used to more efficiently detect key body-points for forming the three-dimensional model; (** Fig.s 1-12, elements 530. 540, 550), (** pg. 6, paragraph 2), (** pg. 6, paragraph 5), (** pg. 48, paragraph 2), (** pg. 49, paragraph 3) • The markers may operate either within the visible or non-visible spectrum; (** Fig.s 1-12, elements 510, 520), (** pg. 48, paragraph 3), (** pg. 49, paragraph 3)
E. "Figure Identification" method to combine with Figure Tracking	• There is no teaching presented to allow for the unique determination of the selected figures identity (e.g. "player 22");	• Each figure may be marked with an encoded marker that is detectable within at least the 1^{st} Set of Camera views and can be translated into each tracked figures unique identity to be matched with their movements; **(* Col 11: 58-64), (* Col: 21: 17-20), (* Col 22: 7-11) -** (** Fig.s 1-12, elements 560, 574), (** pg. 7, paragraph 2), (** pg. 31, paragraph 2)), (** pg. 34, paragraph 3 – pg. 35, paragraph 1), (** pg. 49, paragraph 3), (** pg. 50, paragraph 4 – pg. 51,

		paragraph 1)
	• There is no teaching presented for adhering encoded markers to the upper surfaces of the figures to be tracked in order to support the automatic determination of their identity to be associated with their current centroid location;	• Each figure may be marked with a uniquely encoded reflective, retro-reflective or fluorescent marker on their upper surface to be primarily in view of the 1st Set of Cameras, where the each marker may be more easily detected and decoded into that figures unique identity for association with their current centroid; (** Fig.s 1-12, elements 560, 574), (** pg. 48, paragraph 2), (** pg. 49, paragraph 3) • The markers may operate either within the visible or non-visible spectrum; (** Fig.s 1-12, elements 510, 520), (** pg. 7, paragraph 4), (** pg. 48, paragraph 3), (** pg. 49, paragraph 3)

(2) Review of two comparison figures drawn to highlight the differences between Sengupta and my teachings and claims:

Attached please find the following two Figures drawn to highlight and summarize the differences between Sengupta and my teachings, as follows:

1. "Sengupta et. al": This figure depicts a "Figure Tracking System" attached via controlled switches to multiple fixed and / or moveable cameras that cover some portion, but not necessarily all of, a given predefined tracking area. Hence, the entire view created by all possible tracking cameras is neither contiguous nor is it limited to cover the entire predefined area. Also shown is a figure (in this case a hockey player) that is moving throughout the predefined area; sometimes in view of one or more cameras, sometimes not in view. As the player moves about, the Figure Tracking System e.g. begins tracking by use of fixed camera 1, after which tracking is "handed off" in succession to movable camera 2, fixed camera 3, (player then enters hole in view), fixed camera 4 and finally movable camera 5. At any given moment, the Figure Tracking System receives video data from a single camera (e.g. 1 through 5) that it then uses for image analysis and resulting figure centroid determination. Hence, each camera is not continuously used for tracking, but rather only when a selected figure of interest is first determined to be entering or existing within its potential field of view.
2. "Aman": This figure depicts a "Figure Tracking System" attached to a matrix of two or more fixed overhead X, Y tracking cameras that are limited to form a contiguous view of the entire predefined are. Also shown is the same figure of a hockey player that is moving throughout the predefined area and is always in view of the overhead tracking cameras. The Figure Tracking System continuously receives video from each two or more overhead tracking cameras for analysis throughout the entire predefined tracking time, regardless of whether or not any particular figure / player is within its view. Hence, the overhead tracking cameras are always being processed and always tracking all players, not simply a selected player. One or more movable side view cameras may also be dynamically adjusted to continuously follow the figure or any tracked object. Adjustable side view cameras may also be used for additional analysis by the Figure Tracking System; not for determination of each figure / player / objects X, Y centroid location with respect to the predefined area, but rather for the determination of the current X, Y, Z coordinates of one or more locations / marks on each figure / player. Although not depicted, each player may also be wearing an uniquely encoded marker on some portion of their upper surface, such as their shoulders or helmet, that may be detected and

decoded by the Figure Tracking System using the video captured by the overhead tracking system. This additional information thereby allows the Figure Tracking System to include unique figure / player identity along with the current location / tracking database.

(3) A discussion of the changes incorporated into new claims 97 through 124; especially how they differentiate my invention from the referenced art:

With respect to these new claims, there are two independent apparatus claims 97 and 107 along with similar independent method claims 111 and 121, respectively. Attention will now be paid therefore to new apparatus claims 97 and 107 with the understanding that the discussions are similarly applicable to new method claims 111 and 121 respectively. First, in relation to claim 97, it is most directly comparable to claim prior cancelled claim 61. In a comparison between original claim 61 and new claim 97, especially in light of the recent office action and the prior reference of Sengupta, the following limitations have been added to the new claim 97:

1. The first set of cameras is restricted to "two or more," rather than allowing just one stationary X, Y tracking camera;
2. It is explicitly claimed that the first set of cameras alone is "exclusively responsible" for ongoing centroid X, Y tracking for each participant (i.e. / player / figure / object) throughout the entire time of tracking;
3. It is explicitly claimed that the "current centroid location" of any tracked participant (i.e. / player / figure / object) does not effect each first camera from continuously capturing video for continuous analysis (hence, when a player moves out of one 1st camera's view and into another, both cameras remain in full operation);
4. It is explicitly claimed that the first algorithm is "simultaneously analyzing" the video data from all two or more first tracking cameras, rather than possibly just one camera at a time, and further that it is analyzing "continuous images from each first camera" (i.e. every 1st camera is always on and always being used for tracking, regardless of the presence or not of a participant or object within a given 1st camera's field of view);
5. It is explicitly claimed that first algorithm creates the tracking database "continuously throughout the predefined time" by combining the ongoing "centroid X, Y coordinates" determined from "each and every first set camera";
6. It is explicitly claimed that the second set of movable cameras is "distinct from the first set of stationary cameras," and
7. It is explicitly claimed that the video images from the second set of movable cameras are "not used to either determine any participant's or object's centroid X, Y coordinates or to otherwise update the tracking database."

Second, in relation to claim 107, it is not directly comparable to any original claim 50 through 96 primarily because it is crafted more as a picture claim, thereby incorporating some of the original dependents (such as 66, covering uniquely identifying participants via encoded markings) into the tracking portion of the independent apparatus of claim 97. Especially in light of the recent office action and the prior reference of Sengupta, the following limitations have been added to the new claim 107:

1. The system is for "automatically uniquely identifying and tracking one or more participants… and game objects," where the unique identity is determined from "encoded markers adhered to the top surface of each participant";

2. The first set of cameras is restricted to "two or more," rather than allowing just one stationary X, Y tracking camera;
3. The first set of cameras are by implication "exclusively responsible" for ongoing centroid X, Y tracking for each participant (i.e. / player / figure / object) throughout the entire time duration of tracking, simply because no other cameras (i.e. side view cameras) are included in the claim;
4. It is explicitly claimed that the first algorithm is "simultaneously analyzing" the video data from all two or more first tracking cameras, rather than possibly just one camera at a time, and further that it is analyzing "continous images from each first camera" (i.e. every 1st camera is always on and always being used for tracking, regardless of the presence or not of a participant or object within a given 1st cameras field of view), and
5. It is explicitly claimed that first algorithm creates the tracking database "continuously throughout the predefined time" by combining the ongoing "centroid X, Y coordinates" along with the "determined each participant's and / or object's unique identity" (based upon the "encoded markers adhered onto a top surface") using data (exclusively by implication) from "each and every first set camera."

(4) Summary arguments for the allowance of the revised claims:

As it can be seen, the teachings of my original application for a "Multiple Object Tracking System" as continued in part with the present application for "Optimizations for Live Event, Real-time, 3D Object Tracking," are clearly different from all of the sited art, especially Sengupta. In summary, the differences include, but are not limited to:

1. Two distinct sets of cameras – the first *exclusively for figure centroid tracking* and the second for videoing *without contributing tot centroid tracking*;
2. The first set of cameras *is restricted to covering the entire predefined tracking area* in order to effectively support the claimed multiple object tracking as would, for example, be representative of the needs of a sporting event (as opposed to simply following a figure as it walks around a building);
3. Each camera in the first set *is always tracking, regardless of whether or not any given figure currently exists within its view* – this helps to simplify the complexity of working with a larger number of first tracking cameras, especially when a large number of fast moving and bunching figures are being tracked as would be the case in a sporting event;
4. *Uniquely encoded marks are placed on the upper surfaces* of figures / participants / players / objects to be identified such that this mark can be picked up within the view of the first cameras; thus allowing the first set of cameras to perform the data collection necessary for *both player tracking and identification*, and
5. The second set of movable cameras need *not provide any data to any figure tracking system* or its equivalent and can be restricted to simply gathering videoing of the movement of the figures.

In conclusion, I respectfully request that you allow new claims 97 through 124 as submitted as they clearly differentiate my original teachings contained within U.S. Patent No. 6,567,116 B1 filed on Nov. 20, 1998 entitled "Multiple Object Tracking System," as well as the current continuation of this original application entitled "Optimizations for Live Event, Real-time, 3D Object Tracking." Furthermore, in light of the full support for both independent apparatus claims 97 and 107 as well as parallel independent method claims 111 and 121 respectively, I ask that the invention date for the allowed

claims be set as the original filing date of Nov. 20, 1998, based upon U.S. Patent No. 6,567,116 B1 filed on entitled "Multiple Object Tracking System."

I thank you for your consideration in these matters.

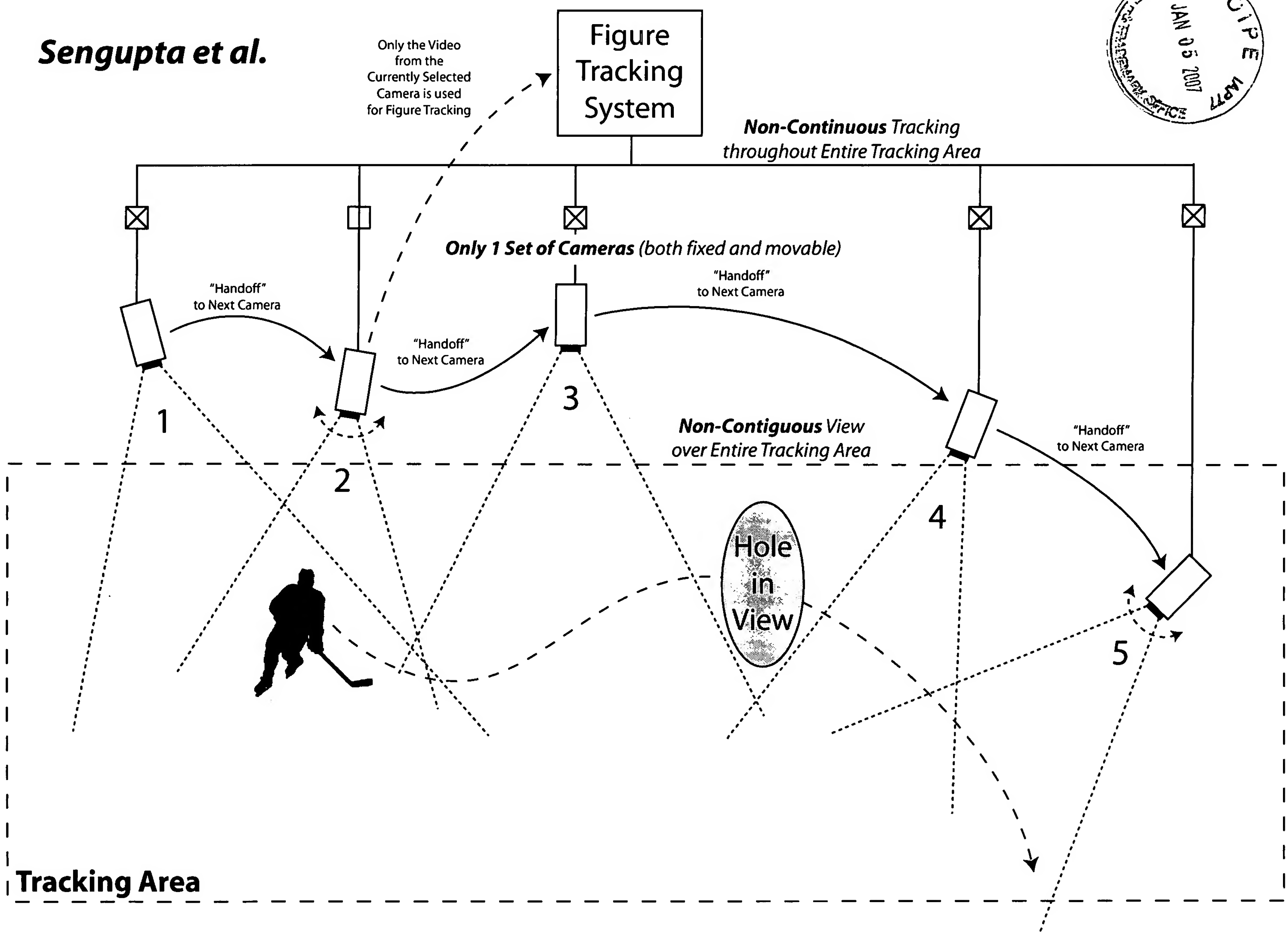
Sincerely,

James A. Aman

This communication was mailed Post Office To Addressee from Lansdale, Pennsylvania on 1/5/07 using label EB 178563449 US Examiner Senfi, Behrooz.

THIS IS NOT A PATENT DRAWING, it is neither a "Replacement Sheet," "New Sheet," or "Annotated Sheet" - this drawing accompanies and is attached to the present inventors response to the current office action dated September 6th, 2006

Sengupta et al.



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Aman